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ABSTRACT

Progress on the University of Texas personalized system of instruction (PSI) project is described. Twelve courses in the College of Engineering and five in other colleges were developed for PSI under a grant from the Alfred P. Sloan Foundation. Each of those courses has now been offered at least once, thus making it possible to begin evaluating the program. Nine questions on the effectiveness, efficiency, student and faculty acceptance, and longer term utility of PSI are discussed. (DGC)

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Seventeen PSI Projects at The University of Texas at Austin

by

James E. Stice

This is a progress report on the PSI project at The University of Texas at Austin, sponsored by a grant from the Alfred P. Sloan Foundation. Under this grant 17 PSI courses were developed by the Associate Investigators, 12 of them in the College of Engineering and five in other colleges. The Associate Investigators and the course each developed are:

1. Structural Dynamics - Roy R. Craig, Assistant Professor, Department of Aerospace Engineering and Engineering Mechanics

2. Design of Structural Systems in Timber - David W. Fowler, Associate Professor, Department of Architectural Engineering

3. Process Analysis and Simulation - David M. Himmelblau, Professor, Department of Chemical Engineering

4. Electrical Engineering Laboratory I - Charles H. Roth, Jr., Professor, Department of Electrical Engineering

5. Electrical Engineering Materials - H. Lyndon Taylor, Associate Professor, Department of Electrical Engineering

6. Introduction to Engineering Analysis - Nancy S. Hamilton, Instructor, Department of Mechanical Engineering

7. Introduction to Nuclear Reactor Theory - Billy V. Koen, Associate Professor, Department of Mechanical Engineering

8. Dynamic Systems Synthesis - Lawrence L. Hoberock, Assistant Professor, Department of Mechanical Engineering

9. Engineering Statics - Wallace T. Fowler, Associate Professor, and Paul E. Nacozy, Assistant Professor, Department of Aerospace Engineering and Engineering Mechanics

10. Engineering Economics - William G. Lesso, Professor, Department of Mechanical Engineering

11. Introduction to Operations Research - Charles S. Beightler, Professor, Department of Mechanical Engineering

12. Probability and Statistics for Engineers - Gerald R. Wagner, Assistant Professor, Department of Mechanical Engineering

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13. Basic Cataloging and Classification - Billie Grace Herring, Assistant Professor, Graduate School of Library Science

14. Freshman English Composition - Susan W. Wittig, Assistant Professor, Department of English

15. Principles of Chemistry - John M. White, Associate Professor, Department of Chemistry

16. Engineering Physics I - Austin M. Gleeson, Associate Professor, Department of Physics

17. Principles of Audio and Visual Production - Robert D. Brooks, Associate Professor, Department of Radio-TV-Film

Each Associate Investigator developed his course and taught it during one semester, then revised the course in light of the feedback received from proctors and students and offered it for a second time. All courses were supposed to follow the "pure" Keller model. In fact, all did not; many professors injected slight variations, depending upon their own teaching styles and personalities. None of these variations was believed to effect the intent of the project. The final report will discuss these variations in detail.

In addition to the development of courses, the project was to investigate nine questions often asked about the PSI technique. These questions will be individually discussed later in this paper, together with the answers we have obtained from the data received to date.

An Advisory Board was selected to provide assistance and guidance to project personnel during the period of the grant. The permanent members of this Advisory Board were : Dr. David G. Born, Department of Psychology, University of Utah; Dr. Ben A. Green, Jr., Center for Personalized Instruction, Georgetown University; Dr. Fred S. Keller, Washington, D.C.; Dr. David T. Pratt, Department of Mechanical Engineering, University of Washington; Dr. J. Gilmour Sherman, Department of Psychology and Center for Personalized Instruction, Georgetown University. In addition, several people served as temporary members of the Advisory Board because of individual expertise they could contribute to the project. These members were: Dr. Amogene F. DeVaney, Department of Mathematics and Engineering, Amarillo College; Dr. Gerhardt F. Paskusz, Associate Dean of Engineering, University of Houston; Dr. E. Joseph Piel, ECCP Project, State University of New York System; Dr. George T. Semb, Department of Human Development, University of Kansas; and Dr. Bernet S. Swanson, Department of Chemical Engineering, Illinois Institute of Technology.

The project began on January 1, 1973 and will terminate December 31, 1975. The questions which we hoped to answer during the course of the project, together with the tenative answers derived from the data analyzed up to this time are:

1. Do students learn more (or better) under the PSI method than under "conventional" methods?

Achievement measures were compared between 11 PSI courses and associated control courses. Students in the PSI courses did significantly better in five

of the courses, there was no difference between the two groups in five courses, and the control class did better than the PSI class in one instance. Thus ten out of the eleven classes did as well or better under PSI than under conventional teaching methods.

All achievement measures were final exam data, except in the case of the Engineering Physics I course. In that course there was no significant difference between the PSI physics class and the control class in an advanced placement test devised by the Department of Physics. The motivation was the same for both groups since the Advanced Placement Test results did not effect the grades of either group of students. The statistical analyses were controlled for grade point average, Scholastic Aptitude Test (SAT) verbal score, SAT quantitative score, SAT total score and where applicable the score on the College Entrance Examination Board Level I Mathematics Achievement Test. This was done to remove initial intergroup differences in aptitude or achievement.

PSI undergraduate students in the mid-range of grade point average and with SAT scores of around 1000 tended to do better than similar students in the control courses. Data are limited and are not statistically significant, but there is a definite trend. In the single graduate course (Library Science), students with a graduate record exam verbal score greater than 600 did better than similar students in the control class. The mean graduate record examination verbal score is 500 for this group, so a score of 600 puts a student in the 84th percentile. It thus appears that the <u>better</u> graduate students in the PSI course did better than their peers. Among the undergraduate students the <u>average</u> students in PSI classes did better than their peers in control classes.

2. <u>Are the higher grades obtained in PSI cours s justified?</u>

In six out of nine comparisons, the A students in control classes scored significantly higher on the final examinations than the A students in PSI courses. In the other three comparisons there was no significant difference between the groups. In no case did the PSI students do better.

In six comparisons of B students, three control classes had better final exam scores, while in two comparisons there was no significant difference, and in one case the B students in the PSI course did better.

It must be pointed out that there was a significant difference in motivation between the PSI students and students in the control classes. In all cases the students in the control classes received a significant portion of their final grade in the course from their final examination. In many cases the grade on the final examination had no effect on the students in the PSI classes and in no case did the PSI students' final examination grade count more than 25% of his course grade. We are obtaining more data from the Engineering Physics I class this spring. Both the PSI section and the control sections will take the Physics Department Advanced Placement Test which will effect the grade of neither group, thus adjusting for the motivational differences present in the comparisons.

3. <u>Do PSI students exhibit a significantly different long-term retention of course content than students in conventional courses?</u>

We did some follow-up studies of students in both PSI and control classes analyzing the grades of both groups in a course that followed the PSI course. The results were mixed.

The PSI course in engineering statics was first offered during the spring of

1973. Students from both the PSI statics course and the conventional statics course later took Engineering Dynamics and/or Strength of Materials. There was no significant difference on final exam scores between the two groups in the Engineering Dynamics course, but the control group scored higher on the final examination in the course on Strength of Materials. The PSI Engineering Statics course was revised during the summer 1973 and offered again during the fall 1973. There was no significant difference between this PSI group and their associated control group in the final examination scores in either Engineering Dynamics or in Strength of Materials. It appears that the PSI Statics course improved as a result of the revision. However, the students in the control class had a significantly higher portion of A's and a significantly lower proportion of D's in Engineering Dynamics. In Strength of Materials the proportion of A's was approximately the same for both classes, but the control had a significantly lower proportion of D grades.

The graduate course in Library Science was compared with its control group with respect to final examination scores in the course following Basic Cataloging and Classification. There was no significant difference between the two groups.

In Introduction to Engineering Analysis (the pre-calculus mathematics course), PSI students made a significantly higher proportion of A, B, and C grades in the first semester of calculus than did their associated control groups. Also, the control group had 39% D's and F's in the first semester of calculus, while the PSI group had only 9% D's and F's. This result was highly significant (p less than .01).

4. Do students in PSI courses learn how to study?

Freshman and sophomore students were pre-tested with the Brown-Holtzman Survey of Study Habits and Attitudes. At the conclusion of the semester the same test was administered as a post-test. The Brown-Holtzman test has seven sub-scales: study oreintation, study attitudes, study habits, delay avoidance, work methods, teacher approval, and education acceptance. In both spring and fall 1973 there was no significant difference between PSI sections and control sections on the delay avoidance sub-scale pre-test. On the post-test this was significant ($p = .07$). On the education acceptance sub-scale pre-test differences were insignificant but the post-test difference was highly significant ($p = .02$), with the PSI students having the higher mean score. These results indicate that PSI students were not as likely to put work off as control students, and that the PSI students were more accepting of educational objectives and practices.

Student objective opinions also were sought to get at an answer to this question. Of 840 students sampled 57% said "Yes" or "Definitely yes", their study habits had improved as a result of PSI. Neutral responses were given by 23%, and 20% said "No" or "Definitely no".

5. Can PSI materials developed by a given professor be used at another University with roughly equal results?

Data to answer this question were obtained from a PSI Summer Institute in Statics which was given at the University of Texas at Austin during the summer of 1973. Twenty-two community college and four-year college teachers attended

this institute, which lasted for a period of nine weeks. These teachers took the course in Engineering Statics which had been developed in the spring of 1973 by Drs. Fowler and Nacozy. All took the course as students; those who finished early proctored their classmates. When everyone had completed the course, the last several weeks were spent in revising it. During the same period, the teachers received continuing instruction in the PSI method, in writing instructional objectives, methods of testing, and classroom management. The enthusiasm of the participants was high, and all considered the institute to have been very successful.

During the following academic year, 11 of the PSI Institute participants used the materials to teach the course at their schools. The other 11 did not do so for several reasons. Some were not able to get a sufficient enrollment to offer the course at their school; three returned to graduate school themselves, and thus were not actively teaching at the time; two others did not teach the following year. Of the 11 participants who used the materials, all said the transfer was successful. Nine said the materials required little revision for use at their home institutions, and nine said the materials were not too difficult for their students. All 11 said that in their opinion the course improved their students' study habits. The 11 participants who taught a PSI Statics course at their own institutions said they would not have wanted to tackle the job without having attended the PSI Summer Institute, and they thought the nine-week time period was about right - eight weeks would have been a minimum.

The participants who taught the PSI course encountered problems. The teachers from the community colleges were unable to get many proctors, because most students transfered to a senior college after completing their course. All said it was difficult to get money to pay the proctors. Also they reported some of their faculty colleagues complained that the Statics course took too much of the students time. Further, the PSI teachers didn't want to acquire the reputation of being "easy" graders. Finally, there were reports of administrative objections to the large proportion of A grades.

The Summer Institute participants who taught the course at their schools devoted approximately one-fourth as much time to teaching the course as the University of Texas at Austin course developers had invested while developing the course.

The only significant difference between results at the University of Texas at Austin and the results at the other schools, was that the number of students dropping the course was significantly larger at the other schools.

6. What are the costs and instructor time requirements of a PSI course?

Cost data on PSI courses are fairly sparse. Student-proctor ratios averaged 10 to 1 across the 17 courses, ranging from 3 to 1 to 16 to 1. This range caused no significant difference in student attitude toward the courses, as expressed on the Course-Instructor Survey (student course evaluations). The average cost per student for each course (not including the professor's salary) was $35.67, with a range of $16.11 to $73.55. The average cost of supplies, secretarial and clerical costs, and reproduction of materials per course was $5.11, with a range of $.04 to $22.20.

During the first offering of the PSI courses, comparisons were made between nine PSI courses and nine associated control courses. The PSI course developers averaged 24 hours per week, the range being 5 to 50 hours. Faculty teaching control courses averaged 12 hours per week, the range being 6 to 18 hours. During the second offering, only two PSI course developers kept a record of their time expenditure, and the average for these two courses was 10 hours per week.

From these data there is no question that a PSI course takes more time than a traditional course in the first semester it is being developed. The time requirement declines to a reasonable level after the period of initial development.

Instructors were requested to rank-order their activities and the fraction of time devoted to each. During the first offering of the course the activities were ranked:

1. Materials preparation
2. Working with proctors and students
3. Record-keeping
4. PSI-related professional interaction (meetings with PSI project group, meetings with advisory board, discussions with colleagues, and invited papers)

In the second and succeeding offerings less time is required for materials preparation, while the interaction with students increases.

7. What are the various causes of procrastination and can it be minimized?

In order to answer this question, it was first necessary to define "procrastination". Members of the evaluation team defined a procrastirator as one whose early rate of progress is such that his required late rate must be twice his early rate in order to finish all units of the course without taking an incomplete. The early period is defined as the first two-thirds of the total number of class days, and the late period is the last third. This means that a student identified as a procrastinator will be covering the same number of units, or more in the last one-third of the course as he did in the first two-thirds.

Using this definition the following conclusions have been drawn (941 students in the sample):

1. Procrastinators have lower grade point averages and SAT scores than non-procrastinators. Among graduate students there is no difference between procrastinators and non-procrastinators on Graduate Record Examination scores.
2. Freshmen and seniors have the highest procrastination rate. No other significant differences were found for student classification.

3. Students taking six hours of course work or less had a lower procrastination rate than students taking ten hours or more.

4. Numbers of hours worked on outside jobs had no effect on procrastination.

5. Previous experience with PSI courses lowered procrastination rates.

6. Students who have had no previous experience with PSI courses are more likely to procrastinate than students who have had a PSI course before. This result is independent of the experienced students' attitudes toward PSI (positive, neutral, or negative).

7. Procrastination rates dropped from the first offering to the second offering of a course. Instructors explained this by pointing out that revision of their materials improved the course.

8. No relationship was found between proctor/student ratios and proportion of procrastinators in a class.

9. Progress lines had mixed effects on procrastination. The use of deadlines or modules (allowing students to take a test over several units at once) had little if any effect.

10. Procrastination does not indicate less mastery.

11. Procrastination had a direct effect on course grade.

8. PSI courses regularly produce a higher drop out rate than regular courses. Can this rate be reduced and if so, how?

Six comparisons were made between PSI and control classes in the spring of 1973. In two of these comparisons the PSI course had a significantly higher rate of dropouts, but in the other four courses there was no significant difference between PSI courses and control courses. Beginning with the fall semester of 1973 and thereafter, the drop rate in PSI courses has not been higher, and in fact has been lower in every case, but the difference is not statistically significant.

At the beginning of the PSI project our plans were to run the courses in a strict self-paced format, allowing students to take a grade of "Incomplete" and to spend as much as an extra semester to complete their PSI course, if they so desired. As a result, 26% of the students taking PSI courses during the spring of 1973 took a grade of Incomplete at the end of that semester. We soon found out that this created some unanticipated problems. The University of Texas at Austin grading policy scores an Incomplete as 0 grade points for X hours of credit, and so until the grade of incomplete is changed into a final grade, it is scored exactly the same as an F. None of the Associate Investigators on the PSI project knew of this policy, nor did several of the personnel in the Registrar's

office. We became aware of it quickly, though, when several good students lost scholarships and others failed to receive invitations to various honor societies because their grade point average was affected.

We quickly changed our policy, and agreed to limit the grade of Incomplete to those cases for which that grade normally would have been employed. Thus our courses were constrained to begin and end on definite dates, although the student's progress within the course was still self-paced. As a result the number of Incomplete grades allowed in the fall semester of 1973 dropped to less than 5%.

It might be mentioned that of the students who received Incompletes in a PSI course 54% completed the course and obtained a final letter grade within one semester.

Personal and telephone interviews were held with 58% of the students who dropped either a PSI course or its matched control course. Students dropping control courses commonly said they weren't doing well in them or were failing. Students dropping the PSI courses all said they had gotten behind. Not one said he was not doing well in the course.

9. What is the effect of class size in PSI courses?

The PSI classes were arbitrarily grouped into "small" classes (10 to 47 students) and "large" classes (65 to 370 students). Students in the small classes tended to react more favorably to PSI on the Course-Instructor Survey, but even students in the large classes were neutral to favorable. No relationship was found between the size of class and the instructor time requirement.

I made a serious blunder when the project began. Every effort was made to keep the various administrators advised about what was going on in their department or in their college with respect to the project. This was done through memos, and I assumed that they were being read and understood. In fact, these administrators were busy people, and although they might have read all this material they didn't necessarily understand it. An attempt to get them together for a one-day workshop failed, because the several people to whom I proposed this idea were unwilling to devote that much time to it. After the project had been in operation for one year, we assembled the deans and department chairmen who had faculty members participating in the project, and they met with the members of our Advisory Board. It quickly became evident that these administrators were not very well informed on what we were doing. It would have been better if I had gotten them together when the project was beginning, even if only for an hour. I would advise anyone who is beginning a PSI course or project in their department to take particular pains to make sure those administrators understand what PSI is, and the way in which it differs from more conventional types of instruction.

The problem with the grade of Incomplete, which has been discussed above, also caused great concern among the project personnel. Since the effects of the university's policy have been recognized, a resolution has been introduced in the Faculty Senate to try to get the policy changed. These recommendations were referred to committee, and no committee recommendation has resulted during the past year. So for the immediate future at least, the PSI courses are allowing the grade of Incomplete only for conventional reasons.

Unusually large enrollments caused complications in at least two of the courses developed in the project. Prior to the fall of 1973 the enrollment in Electrical Engineering Laboratory I had never exceeded 90 students. Thus Dr. Roth made preparations for handling 90 students in his self-paced version of the course, only to be greeted by 118 registrants! By the time the course had begun he was unable to obtain the additional laboratory equipment needed, and he was also unable to obtain additional proctors, as the upperclassmen and graduate students who would have been suitable had accepted other part time employment. He further discovered that although a proctor-to-student ratio of 1 to 10 was satisfactory for a lecture course he had developed earlier, this ratio was not sufficient for a laboratory course, and a ratio of 1 proctor to 6 students was more realistic. His course did not run smoothly during the fall semester. When the course was offered for the second time during the spring of 1974, the new laboratory equipment had been received and installed, and he had arranged for the larger number of proctors needed. Also the enrollment in the course was normal. As a result the second offering was quite successful.

The PSI course in Engineering Physics I was similarly plagued with unusual enrollment. The projected engineering enrollment in this course was about 300 students, who were to be about evenly divided between the PSI section and a section taught by conventional methods. The actual enrollment was about 600 students, requiring two sections taught by conventional methods and a PSI section of 370 students. The unexpected problems with which Dr. Gleeson had to cope included a shortage of textbooks for the first month, a student population in the self-paced laboratory which was very much larger than anticipated, and a shortage of available proctors. The course nevertheless was a success, and during the second offering it is proceeding very smoothly.

I have been very interested in following the fate of the seventeen courses developed in this project when the outside funding disappeared. Although it is rather early to draw any conclusions, indications are that at least twelve of the courses have been assimilated into the various departmental curricula, and will continue to be offered using the PSI format. Three will be taught by PSI when the Associate Investigator developing the course teaches that course, and only two are in the questionable category. The courses which seem to be permanent are: Structural Dynamics (Craig); Design of Structural Systems in Timber (D. Fowler); Process Analysis and Simulation (Himmelblau); Introduction to Engineering Analysis (Hamilton); Introduction to Nuclear Reactor Theory (Koen); Dynamic Systems Synthesis (Hoberock); Engineering Economics (Lesso); Introduction to Operations Research (Beightler); Probability and Statistics for Engineers (Wagner); Freshman English Composition (Wittig); Engineering Physics I (Gleeson); and Principles of Audio and Visual Production (Brooks). The courses which will be taught using PSI when the course developer teaches them include Electrical Engineering Laboratory I (Roth), Principles of Chemistry (White), and Engineering Statics (W. Fowler and Nacozy). Those courses which may not be taught using PSI in the future are Basic Cataloging and Classification (Herring) and Electrical Engineering Materials (Taylor).

Interpretation of the data acquired by the evaluation team continues, and further data are being obtained in the form of follow-up studies. A final project report is in preparation and should be available sometime during the summer of 1975.